HIV-1 infection in high risk men who have sex with men in Mombasa, Kenya

Eduard J. Sanders[a,b], Susan M. Graham[c], Haile S. Okuku[a], Elise M. van der Elst[a], Allan Muhaari[a], Alun Davies[a], Norbert Peshu[a], Matthew Price[d], R. Scott McClelland[c] and Adrian D. Smith[e]

Background: The role of homosexuality and anal sex practices in the African HIV -1 epidemic is not well described. We aimed to assess the risk factors for prevalent HIV-1 infection among men who have sex with men (MSM) to guide HIV-1 prevention efforts.

Methods: Socio-behavioural characteristics, signs and symptoms of sexually transmitted diseases (STD), and serological evidence of HIV-1 were determined for 285 MSM at enrolment into a vaccine preparedness cohort study. We used multivariate logistic regression to assess risk factors for prevalent HIV-1 infection.

Results: HIV-1 prevalence was 43.0% [49/114, 95% confidence interval (CI), 34–52%] for men who reported sex with men exclusively (MSME), and 12.3% (21/171, 95% CI, 7–17%) for men who reported sex with both men and women (MSMW). Eighty-six (75%) MSME and 69 (40%) MSMW reported recent receptive anal sex. Among 174 MSM sexually active in the last week, 44% reported no use of condoms with casual partners. In the previous 3 months, 210 MSM (74%) reported payment for sex, and most clients (93%) were local residents. Prevalent HIV-1 infection was associated with recent receptive anal sex [odds ratio (OR), 6.1; 95% CI, 2.4–16], exclusive sex with men (OR, 6.3; 95% CI, 2.3–17), and increasing age (OR, 1.1 per year; 95% CI, 1.04–1.12). Only four MSM reported injecting drug use.

Conclusions: The high prevalence of HIV-1 in Kenyan MSM is probably attributable to unprotected receptive anal sex. There is an urgent need for HIV-1 prevention programmes to deliver targeted risk-reduction interventions and STD services to MSM in Kenya.

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Background

Male homosexual partnerships and anal sex practices have rarely been investigated in Africa, in contrast to their detailed characterization as key risk factors for HIV-1 infection elsewhere [1]. Unprotected penile–vaginal intercourse has been assumed to drive transmission of HIV-1 among adults in Africa, focusing research on high-risk populations such as female sex workers (FSW), [2] sero-discordant couples, [3,4] and persons in concurrent partnerships [5]. Anal intercourse has rarely been reported as a measured risk factor in African surveillance or research characterizing HIV-1 risk behaviours, despite a continuing search to explain the heterogeneity in severity of epidemics between different populations in Africa [6–8].

From the [a]Centre for Geographic Medicine Research – Coast, Kenya Medical Research Institute (KEMRI) – Kilifi, Kilifi, Kenya, the [b]Centre for Clinical Vaccinology and Tropical Medicine, University of Oxford, Headington, UK, the [c]University of Washington, Seattle, Washington, the [d]International AIDS Vaccine Initiative, New York, USA, and the [e]Department of Public Health & Primary Care, University of Oxford, Headington, UK.

Correspondence to E.J. Sanders, MD, PhD, Box 230, Kilifi, Kenya.

E-mail: ESanders@kilifi.kemri-wellcome.org
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Sex between men and participation in sex work remain illegal and socially stigmatizing in many African countries, [9] and political and cultural barriers make research into anal intercourse practices difficult. In the few studies in which anal intercourse have been included, researchers have been concerned about misunderstanding and measurement error due to stigma [10]. Similarly, the vulnerability to HIV-1 infection of men who have sex with men (MSM) has been largely ignored in Africa, with the first study of HIV-1 amongst MSM from Africa published only in 2005 [11]. Throughout sub-Saharan Africa, there is a distinct lack of services for the prevention, diagnosis, and treatment of diseases transmitted by anal sex, and of interventions targeted toward MSM.

Active populations of MSM have long been known to exist in East Africa [12]. Local terminology for homosexuality exists in Ki-Swahili dictionaries from the nineteenth century [13] and there are detailed anthropological accounts of transgender identification, same-sex orientation and homosexual behaviour that predate the global emergence of HIV [14]. Since 2005, we have been recruiting volunteers at higher risk for HIV-1 infection into a vaccine preparedness cohort. Unexpectedly, several male volunteers admitted to having sex with men. Our preliminary investigations and those of other researchers suggest that anal intercourse and other sexual acts between men are more common in Kenya than previously thought.

In 2006, we used a capture–recapture methodology to estimate that 739 MSM [95% confidence interval (CI), 690–798] were selling sex in and around Mombasa; [15] a similar population has been described in Nairobi [16]. Neither of these population-based surveys assessed the prevalence and risk factors for HIV-1 and other sexually transmitted diseases in the Kenyan MSM population. In the current study, we describe socio-behavioural characteristics and risk factors for HIV-1 infection among MSM in the Mombasa area.

Methods

Study population

Since July 2005, populations in and around Mombasa at higher risk for HIV infection have been targeted for recruitment into an HIV-1 vaccine preparedness cohort. The present study focuses on MSM, a group for which targeted recruitment began in 2005 [17]. Identification and recruitment of potential MSM study participants was conducted by a team of 10–15 trained peer mobilizers, who approached individuals via personal networks and at venues at which MSM meet to establish contact with partners and clients. The criteria for MSM enrollment was a self-report of any anal sex within the last 3 months. The research clinic is situated approximately 20 km north of Mombasa in a busy suburb with regular bus and *matatu* (minibus) connections. Mombasa is the second largest town in Kenya (population $>900\,000$), with a busy commercial sea port and an international airport serving large numbers of tourists.

Data collection

Prospective participants were invited to attend a drop-in centre where they received information about research participation, watched a consent video, and met with a pre-enrolment counsellor. Upon enrolment, a detailed sociodemographic and sexual behavioural history was established by face-to-face interview. Participants were asked if they had previously tested for HIV, and if so the result (if known). Blood was collected for HIV-1 and syphilis screening following the risk assessment.

A standardized medical history and physical examination, including genital (and rectal, if clinically indicated) examination was conducted and recorded by study clinicians. From September 2006, proctoscopy was offered to participants practicing receptive anal sex or experiencing anal symptoms. Syndromic treatment was administered for symptomatic urethritis or proctitis in accordance with World Health Organization treatment guidelines [18]. Participants who were HIV-1-positive at screening were offered enrolment into a parallel HIV-1-positive cohort. Clinical care and referrals were provided irrespective of study participation.

Laboratory procedures

Whole blood was tested for HIV-1 on site using two rapid test kits (*Determine*, Abbott Laboratories, Abbott Park, Illinois, USA; *Unigold*, Trinity Biotech plc, Bray, Ireland) in parallel. Discrepant rapid HIV test results were resolved by a fourth-generation HIV-1 antigen/antibody assay performed at the Kenya AIDS Vaccine Initiative Laboratories in Nairobi [19]. Active syphilis was diagnosed by positive rapid plasma reagin (RPR) titre confirmed by the *Treponema pallidum* haemagglutination assay (TPHA), at KEMRI, Kilifi. Gram staining of discharge was performed when symptoms or signs of an infection were present. Urethritis and proctitis were confirmed by microscopic observation of ≥ 5 white blood cell (WBC) per oil emersion field and attributed to *Neisseria gonorrhoea* where Gram-negative, intracellular diplococci were identified [18].

Data management and analysis

Questionnaire, clinical and laboratory data were entered into a secure database. Individual and aggregate data were subjected to routine accuracy checks by research staff and periodic review by study monitors. Data cleaning, recoding and analysis were conducted using Stata 9.2 [20]. Sociodemographic and behavioural risk factors for prevalent HIV-1 infection were summarized for men who reported sex with men exclusively versus men who reported sex with both men and women. Categorical variables were tested using chi-squared or Fisher's exact

tests. Nonnormally distributed continuous and categorical data were compared using the Wilcoxon ranksum test and Spearman rank correlation [21]. Where reported, *P* values are two-tailed.

Logistic regression was performed to estimate odds ratios (OR) for risk of HIV-1 sero-positivity. All variables associated with HIV-1 status in univariate analysis at a *P*-value < 0.2 were entered into a multivariate model. Variables were evaluated using backward stepwise estimation, and retained in the final model where an association with HIV-1 status persisted (P-value < 0.2). All regression analyses were restricted to persons not known to have tested HIV-1 positive prior to this study ($n = 278$), to avoid bias caused by behaviour change after status was learned. Analyses of exclusive sex act preference were restricted to participants reporting anal intercourse in the last 3 months ($n = 279$).

Ethical approval

The study was granted approval by the National Ethical Review Committee under Kenya Medical Research Institute (KEMRI). All participants provided written, informed consent.

Results

Between August 2005 and April 2007, 285 men who reported sex with men were identified; 114 men reported sex with men exclusively (MSME) and 171 men reported sex with both men and women (MSMW). MSM formed approximately one-third of the vaccine-feasibility enrolment population screened; other risk groups screened included 339 women and 210 men at high risk of heterosexually acquired HIV-1 infection.

Sociodemographic characteristics

Table 1 presents the sociodemographic characteristics of these men, comparing MSME with MSMW. MSME were younger than MSMW, but had similar levels of education. Only 18% of MSM in either category were formally employed. MSME reported possession of a greater number of material assets than MSMW. Although the majority of MSM were single, MSMW were most likely to be married, presently or previously. Most MSM identified with an organized religion. Although MSME were significantly more likely to do so, there were no significant differences in the religion identified (Catholic, Protestant or Muslim). Over 90% of these men were circumcized.

Sexual risk behaviour

Almost all MSM (98%) reported participation in anal intercourse in the prior 3 months. Of MSM who reported anal intercourse in the last 3 months, 37% (104/279) reported that all episodes had been unprotected by condoms. Over three-quarters of MSM (82%, 224/279) reported at least one episode of unprotected anal

Table 1. Sociodemographic characteristics.

	MSME $N = 114$ (% or median)	MSMW $N = 171$ (% or median)	*P* value[a]
Age			
Median age in years (IQR)	27 (23–29)	28 (23–35)	0.107
Level of education			
Median years in education (IQR)	8 (7–11)	8 (6–11)	0.336
Employment			
None	54.4	45.0	0.182
Self	27.2	37.4	
Formal	18.4	17.5	
Personal assets			
Private toilet	34.2	22.8	0.030
Piped tap water	61.5	53.7	0.023
Electricity	52.9	37.4	0.020
Television	29.8	19.7	0.021
Mobile phone	28.9	17.0	0.006
Median asset count (IQR)	2 assets (0–3)	1 asset (0–2)	0.001
Marital status			
Single	95.6	77.2	< 0.001
Married	2.6	9.9	
Separated or widowed	1.8	12.9	
Religion			
Catholic	25.4	25.2	0.091
Protestant	26.3	17.5	
Muslim	40.4	40.9	
Other	0.9	1.2	
None	7.0	15.2	
Circumcision status			
Reported or observed	90.1 101/112[b]	93.3 154/165[b]	0.431

IQR, inter-quartile range; MSME, men reported sex with men exclusively; MSMW, men reported sex with both men and women.
[a]Two-sided value based on χ^2 test for proportions or Wilcoxon rank sum test.
[b]Circumcision status missing for two MSME and six MSMW.

Table 2. Sexual risk behaviour and sexually transmitted diseases.

	MSME $N=114$	MSMW $N=171$	
	N (%) or median (IQR)	*N* (%) or median (IQR)	*P* value[a]
Number of different sexual partners (last month)			
Regular	1 (0–1)	1 (0–1)	0.312
Casual	2 (0–4)	2 (1–5)	0.109
Commercial, group, and nonconsensual sex (last 3 months)			
Received money or goods for sex	85 (74.6)	125 (73.1)	0.784
Paid another person for sex	23 (20.2)	86 (50.3)	<0.001
Participated in group sex	18 (15.8)	23 (13.5)	0.581
Forced to have sex	8 (7.0)	4 (2.3)	0.054
Participation in anal sex (last 3 months)			
Any insertive anal sex	52 (45.6)	155 (90.6)	<0.001
Any receptive anal sex	86 (75.4)	69 (40.4)	<0.001
Both insertive and receptive anal sex	28 (24.6)	55 (32.2)	0.166
Condom use with regular partners (previous week)			
Always used	15 (27.8)	22 (27.8)	0.983
Never used	33 (61.1)	49 (62.3)	
Total reporting sex with regular partner last week	54	79	
Condom use with casual partners (previous week)			
Always used	26 (42.6)	42 (37.2)	0.391
Never used	28 (45.9)	49 (43.4)	
Total reporting sex with casual partner last week	61	113	
Condom use with anal sex (previous 3 months)			
Always used	16 (14.6)	35 (20.7)	0.315
Never used	40 (36.4)	64 (37.9)	
Total reporting anal sex in last 3 months	110	169	
Intravenous drug use (last 3 months)			
Yes	1 (0.9)	3 (1.8)	0.537
Clinical signs of STD (at enrolment)[b]			
Urethral discharge	26 (23.2)	36 (21.8)	0.784
Penile ulceration	4 (3.6)	7 (4.2)	0.779
Peri-anal condylomata	5 (4.8)	5 (3.4)	0.585
Peri-anal ulcer	4 (3.8)	3 (2.2)	0.450
Laboratory investigations			
TPHA and RPR seropositive	8 (7.0)	2 (1.2)	0.009
HIV-1 seropositive	49 (43.0)	21 (12.3)	<0.001

IQR, inter-quartile range; MSME, men reported sex with men exclusively; MSMW, men reported sex with both men and women; RPR, rapid plasma regain; STD, sexually transmitted diseases; TPHA, *Treponema pallidum* haemagglutination assay.
[a]Two-sided value based on χ^2 test for proportions or Wilcoxon ranksum test for medians.
[b]Missing records for STD data: MSME: urethral discharge and penile ulceration (2 missing), peri-anal condylomata (9) and peri-anal ulcers (9). MSMW: urethral discharge and penile ulceration (6 missing), peri-anal condylomata (24), peri-anal ulcers (33).

intercourse with any partner in the last 3 months. Reported use of condoms did not vary significantly by the type of anal intercourse most practiced.

Table 2 presents information on sexual risk behaviours, comparing MSME with MSMW. There were no differences in numbers of regular or casual partners in the last month. MSMW were significantly more likely to have paid another person for sex. Twelve (4%) MSM reported having been raped in the last 3 months; this was reported more often by MSME than MSMW. MSME were significantly more likely than MSMW to have practiced receptive anal intercourse and significantly less likely to have practiced insertive anal intercourse. A higher proportion of MSME than MSMW reported practicing both insertive and receptive anal intercourse in the past 3 months (not statistically significant).

Transactional sex and intravenous drug use

Most MSM (74%) reported selling sex for money or goods in the previous 3 months and 40% of whom reported buying sex as well. Forty-nine MSM (17%) reported neither selling nor buying sex. MSME and MSMW who reported selling sex had similar numbers of clients in the last week (median one versus one, $P=0.223$). MSM selling sex reported higher numbers of casual sexual partners in the last month than MSM not selling sex (median three casual partners versus zero, $P<0.001$), and were more likely to report unprotected sex with casual partners in the last week (41 versus 25%, $P=0.013$). There was no difference in numbers of regular partners (median one versus one, $P=0.133$). Among sex workers, personal asset ownership was inversely correlated with the number of clients in the past week (Spearman's rho -0.17, $P=0.016$). Of MSM reporting having sold sex, 44% (86/197) did so on the streets or beach and 34% (66/197) in bars and nightclubs. Where reported, the vast majority of recent MSM clients were Kenyan residents (128/138, 93%) of whom 52% were of African origin, 28% Arab origin and 9% Indian origin. A minority of MSM clients (local or visitor) were of Caucasian origin (9/138; 6%). Only four participants

(1.4%) reported the use of intravenous drug use in the last 3 months.

Sexually transmitted diseases

Among 277 participants undergoing genital examination, 62 (22.4%) had urethral discharge at enrolment screening, of which 16.1% were confirmed microscopically (3.2% gonococcal and 12.9% non-gonoccocal urethritis). Prevalence of peri-anal condylomata was significantly higher in men reporting receptive anal intercourse (6.3 versus 0.9% (no receptive anal intercourse), $P = 0.032$. The same trend was apparent for prevalent peri-anal ulceration, but differences were not significant (3.5 versus 2.0%, $P = 0.506$, data not shown).

Overall HIV-1 prevalence at enrolment was 24.5% (95% CI, 19.7–30.7%). By contrast, HIV-1 prevalence at cohort enrolment was 31.5% (95% CI, 27–36%) for female sex workers and 12.4% (95% CI, 8–17%) for high-risk heterosexual men. Overall, 25.3% MSM reported previous HIV testing, of whom five MSME and two MSMW disclosed they had tested HIV positive.

Table 2 also presents data on sexually transmitted diseases (STD), comparing MSME with MSMW. There were no significant differences in clinical signs of STD at enrolment between these groups. The HIV-1 prevalence was markedly higher, however, in MSME than in MSMW (43.0 versus 12.3%, $P < 0.001$). MSME were also more likely than MSMW to have serological evidence of active syphilis (7.0 versus 1.2%, $P = 0.009$).

Risk factors for HIV-1

Participation in any receptive anal sex in the past 3 months was strongly associated with HIV-1 positivity (unadjusted OR, 4.7; 95% CI, 2.4–9.2). This association persisted when adjusted for age group, religious group, partner preference, anal intercourse without condom (3 months), intravenous drug use (3 months), paying for sex (3 months), peri-anal warts or ulcers, and prior negative testing for HIV-1 (OR, 6.1; 95% CI, 2.4–15.5). In comparison with persons reporting only insertive anal intercourse, the risk of HIV-1 was significantly higher for those reporting only receptive anal intercourse and higher still for those reporting both (Table 3).

Table 3 also shows the analysis of other identified risk factors for prevalent HIV-1 infections. MSME were significantly more likely to be HIV-1 positive in comparison with MSMW (OR, 6.3; 95% CI. 2.3–17, adjusted for other risk factors as above). Clinical evidence of peri-anal condylomata was independently associated

Table 3. Selected crude and adjusted risk factors for HIV-1[a].

	HIV-1 prevalence		Adjusted odds ratio (OR) for HIV-1 seropositivity[d]		
	HIV-1 positive *N* (%)	Total *N*	OR	95% CI	Wald *P* value
Anal sex acts (last 3 months)					
Insertive AI only	12 (9.8)	123	ref	–	
Receptive AI only	26 (37.7)	**69**	**3.9**	**1.4–11**	**0.012**
Receptive and insertive AI	25 (30.9)	**81**	**8.0**	**2.9–22**	**<0.001**
Sex of partners (last 3 months					
Men only (MSME)	43 (40.9)	**105**	**6.3**	**2.3–17**	**<0.001**
Men and women (MSMW)	20 (11.9)	168	ref	–	
One or more unprotected AI acts (last 3 months)					
Yes	56 (25.0)	224	2.3	0.8–6.7	0.147
No	7 (14.3)	49	Ref	–	
Peri-anal condylomata on examination[c]					
Yes	7 (70.0)	**10**	**5.1**	**1.1–24**	**0.040**
No	53 (22.9)	231	Ref	–	
Peri-anal ulceration on examination[c]					
Yes	3 (60.0)	5	5.9	0.6–57	0.124
No	55 (24.2)	227	Ref	–	
Intravenous drug use (last 3 months)					
Yes	2 (50)	4	13.1	0.95–180	0.055
No	61 (23.1)	269	Ref	–	
Age (years)					
18–24	17 (17.7)	**96**	**1.10 (per year)**	**1.04–1.2**	**0.001**
25–34	33 (26.2)	130			
35+	12 (25.5)	47			
Paid another person for sex (last 3 months)					
Yes	14 (13.2)	**106**	**0.38**	**0.15–0.99**	**0.049**
No	49 (29.3)	167	Ref		

AI, anal intercourse; CI, confidence interval.
[a]Restricted to 273 participants reporting AI in the past 3 months (six excluded), and not known to be HIV-1 positive prior to study (seven excluded).
[b]Multivariate adjustments also made for belonging to any organized religious group (y/n) and tested negative prior to study (y/n). Bold text indicates statistical significant adjusted risk factor associations ($P < 0.05$).
[c]Missing entries analysed as additional category (data not shown); missing records: peri-anal condylomata (32 records), peri-anal ulceration (41 records).

with HIV-1 positivity (adjusted OR, 5.1; 95% CI, 1.1–24). An apparent relationship between peri-anal ulceration and prevalent HIV-1 was not statistically significant. Recent intravenous drug use was strongly associated with HIV-1 positivity, but this was rarely reported.

Discussion

The present study is the first study describing HIV-1 prevalence and risk factors in a large group of East African MSM. Men who admitted to sex with men exclusively had a high HIV-1 prevalence (43.0%), which was significantly higher than bisexual men (12.3%). This high HIV-1 prevalence among MSM contrasts with the 2005 UNAIDS estimate for adult prevalence (15–49 years) of 6.1% (95% CI, 5.2–7.0%) in Kenya [22]. The MSM in this study reported high levels of receptive anal intercourse and very low condom use. The majority of these MSM were paid for sex in the previous 3 months, and commercial sex was associated with greater sexual risk-taking.

Anal receptive sex, practiced by 75% of the MSME and 40% of the MSMW, and both anal receptive and insertive sex, practiced by 25% of MSME and 32% of MSMW, were strongly associated with HIV-1 infection. Preliminary follow-up of MSM who were HIV-1 negative at enrolment supports these main findings. Within a total MSM cohort follow-up period of 92 person-years of observations (pyo), crude HIV-1 incidence was 8.8 per 100 pyo (95% CI, 2.2–35.2) among men reporting insertive anal intercourse only, 12.9 per 100 pyo (95% CI, 4.2–40.0) among men reporting receptive anal intercourse only, and 20.4 per 100 pyo (95% CI, 7.6–53.8) among men reporting both insertive and receptive anal intercourse [17,23].

Exclusive preference for male partners was associated with prevalent HIV-1 infection. HIV-1 prevalence odds were higher for MSM reporting unprotected versus protected anal intercourse in the last 3 months, but this did not achieve statistical significance. We were not able to identify numbers of partners or unprotected sex with partners as risk factors for HIV-1 infection, suggesting limitations of our data. Plausible explanations for the finding that men paying for sexual services in the past 3 months were less likely to be HIV-1-seropositive include more consistent condom use or higher rates of insertive role-taking when sex is purchased. We were not able to explore this further in the present study, however, due to the way our questions were structured.

There are several limitations to this cross-sectional study of MSM enrolling in a vaccine feasibility cohort. Firstly, although our enrolment criteria included any sexually active MSM, our informant-led community mobilization identified mostly MSM who sell sex. Sex workers usually represent a small but more highly sexually active fraction of a wider MSM population. We strongly suspect our findings are not generalizable to all MSM in Mombasa, particularly those with no links to the sex trade. Further study is underway to identify and engage these men and to better our understanding of the links between sex workers, their clients and the general population. Secondly, questionnaire-based recall of sexual behaviour and risk prevention is known to be subject to numerous respondent biases [24]. Recent risk behaviour is likely to be a relatively poor reflection of cumulative long-term sexual risk behaviour and changes in behaviour over time. Although the higher degree of stigma associated with receptive anal intercourse may have resulted in some misclassification of this behaviour, this would likely result in an underestimate of the association between receptive anal intercourse and HIV-1 infection.

Personal accounts of formative sexual experiences of some of these men are comparable with accounts given by homosexual men elsewhere. The observation that recent partner numbers are, however, inversely related to personal asset ownership among sex workers suggests that for some men, participation in same-sex activity may be due to economic hardship. MSME, locally referred to as *queens*, are more likely to self-identify as 'gay'. Sex workers who sell sex to both men and women often practice only insertive anal intercourse with men, and are locally referred to as *kings*. Kings tend to reject notions of same-sex sexuality. Further socio-behavioral research aimed at clarifying sexual role segregation and versatility (both receptive and insertive anal intercourse) will be key in designing and implementing targeted HIV-1 prevention measures, and understanding the role of MSM behaviour in HIV-1 transmission dynamics [25].

The extremely high HIV-1 prevalence and low condom use among these MSM calls for urgent public health action. Our study rejects the hypothesis that the local MSM sex trade exists to cater for demand by international visitors, and we also directly challenge another prominent local opinion: that same-sex behaviour among men is done to support intravenous drug habits. Although the high risk of HIV-1 among MSM who are intravenous drug users highlights the need for specific intervention, this risk behaviour was reported by only four MSM (1.4%).

That MSM have received little attention as a group vulnerable to HIV-1 infection in Kenya, and in Africa in general, remains puzzling in the face of the historic anthropological record documenting the group's existence [14]. MSM in Africa often face profound social and political denial and stigmatization [26]. That our research unit has gained an enduring acceptance from MSM, despite its relative distance from central Mombasa, owes

much to the diligence and enthusiasm of peer workers drawn from the MSM community, but we also note the lack of other safe, 'MSM-friendly' health services in the area. Our experience also confirms that MSM can be motivated participants within research programmes, [17] as loss to follow up is markedly lower than among heterosexual men and women.

In summary, this is the first report of anal sex practice by a large group of MSM in relation to HIV-1 infection in East Africa. Unprotected receptive anal sex is common, especially among MSM who sell sex, and is strongly associated with HIV-1 infection. Our preliminary findings are consistent with early studies of HIV-1 risk and MSM sexual behaviours in Western contexts [27]. Commercial sex work is more common in Kenya, however, due to high rates of unemployment and lack of opportunities for further education and training. Local residents who do not identify as 'gay' are often clients of MSM sex workers. We believe there is an urgent need to address the sexual health needs of MSM sex workers and their clients. With promising evidence to suggest that adult HIV-1 prevalence in Kenya may be falling [28], the provision of appropriate interventions targeting high-risk, marginalized groups will be crucial to further advances in HIV-1 prevention.

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